

Greek colonization of the Black Sea: a paleopathological study. A. KEENLEYSIDE, Dept. of Classics, Royal Holloway College, University of London, Egham, Surrey, U.K., TW20 0EX.

Greek colonization of the Black Sea has been the subject of much discussion and debate in recent years. The opening up of eastern Europe to western scholars has resulted in the establishment of a number of collaborative projects involving the excavation of Greek archeological sites on the Black Sea coast. This research has focused on determining the foundation dates for the earliest Greek colonies, investigating the reasons for their establishment, and determining the relationship between colonists and local indigenous populations.

In the first study of its kind from this region, the skeletal remains of nearly one hundred individuals recently excavated from the 4th century B.C. necropolis of Apollonia, an early Greek colony on the Black Sea coast of Bulgaria, and the remains of nearly 30 individuals from a 6th-5th century B.C. necropolis associated with the Greek colony of Histria on the Black Sea coast of Romania, were analyzed for evidence of trauma, specific and non-specific infections, cribra orbitalia and porotic hyperostosis, and dental pathology. The purpose of this research was to 1) reconstruct the health of early Greek colonists to the Black Sea, 2) compare the health status of different colonies on the western Black Sea coast, and 3) assess temporal changes in health.

The paleopathological data revealed that approximately 50% of the skeletons from Apollonia had cribra orbitalia and dental caries, while 20% had enamel hypoplasia. In contrast, trauma and infection were infrequent, each affecting less than 10% of the sample. In comparison to the remains from Apollonia, those from Histria exhibited lower frequencies of cribra orbitalia and dental caries (approximately 33% and 14% of individuals respectively), but higher frequencies of cranial trauma and enamel hypoplasia (17% and 50% respectively). Although the small sample sizes make it difficult to draw any definite conclusions regarding temporal changes in health among Greek colonists of the western Black Sea coast, the data from Apollonia and Histria suggest that patterns of health and disease among the Greeks changed from the archaic to the hellenistic period.

Age at first molar emergence in *Afropithecus turkanensis*. J. KELLEY, College of Dentistry, University of Illinois, Chicago, IL 60612.

Life history one is one of the most fundamental aspects of a species' biology. I have hypothesized that life history may have been a principal adaptive factor in the divergence of monkeys and apes, and that this might be reflected in early Miocene representatives of the two groups (Kelley, 1997). Across a wide spectrum of extant primates, mean age at first molar (M1) emergence is correlated with a number of individual life history traits relating to rate of maturation. Age at M1 emergence can therefore serve as a substitute for approximating overall rates of maturation in comparative contexts.

Here I report an estimated age at M1 emergence in KNM-MO 26, a juvenile mandible of *Afropithecus turkanensis* from the early Miocene site of Moruorot, Kenya. MO 26 preserves an erupting first molar and a partially formed lateral incisor in its crypt. The latter was exposed and found to have excellently preserved perikymata from near the crown apex to the developing cervical enamel. The perikymata count was combined with data on dental growth in *Proconsul* species (Beynon et al., 1998) — daily increments between perikymata, duration of cuspal enamel formation, and postnatal delay in incisor calcification — to provide an estimated age at death. Time remaining to gingival emergence was estimated using data from an ongoing radiographic study of M1 growth and emergence in *Papio anubis*. Data from other species were used in such a way so as to produce a conservative estimate of age at M1 emergence. The estimated age at M1 emergence of 27.7 months falls within the known range of emergence ages for *Pan* and considerably above the maximum age for the few cercopithecoids, including *P. anubis*, for which ranges of individual emergence ages are known.

Interpreting these results in terms of life history is complicated by an estimated mean body mass for *A. turkanensis* approximately equal to that of smaller female chimpanzees. However, the estimated age at M1 emergence is not inconsistent with at least a shift toward the prolonged maturation characteristic of extant apes.

Supported by NSF grant SBR-9408664.

Dental and Postcranial Skeletal Changes in an Historic Chumash Population. C.M. KELLNER; University of California, Santa Barbara; Department of Anthropology; Santa Barbara, California 93106.

A skeletal collection from the historic (1780s to 1820s) Chumash interior village of Awhay is of special interest because it dates from a stressful period of rapid cultural change when the Chumash abandoned their villages and moved to the missions. Little is known about the lives of those Chumash who resisted conversion and continued to live outside the mission system.

Many researchers have noted that body size and tooth size are detrimentally affected in populations experiencing stressful situations. Measurements of long bones and the permanent dentition of over 100 individuals interred at Awhay was analyzed to obtain information on the biological consequences the Mission system had on the Chumash who remained in their native villages. The body size and tooth size of Awhay's population was compared with the historic and prehistoric inhabitants of the coastal Chumash village Humaliwu.

These data reveal that body size and tooth size changed from prehistoric to historic times in the Santa Barbara Channel region. Interestingly, while Awhay individuals were somewhat in the midrange of values for the femoral, tibial, and dental measurements when compared with the prehistoric and historic populations at Humaliwu, their humeral dimensions were slightly larger than either of the populations from Humaliwu.

Increased distance from the Mission system may have better buffered the Awhay population from the deleterious effects of Spanish contact. The seemingly anomalous humeral measurements may point to a change in activity, possibly associated with the advent of agriculture labor. This pattern highlights the complexity of the Chumash-European relationship. Research was supported by funding from the UCSB Summer Academic Research Mentorship Program.

Osteological evidence for population replacement in the Channel Islands region of California, S. L. KERR and G. M. HAWLEY, Department of Anthropology, University of California, Santa Barbara, CA 93106

Archaeological research in the southern Channel Islands region of California suggests that migration resulted in a population replacement on the islands sometime during the past 6,000 years. This conclusion is drawn primarily from archaeologically recorded shifts in artifact assemblages and dietary habits on the islands. Osteological analysis by Walker and Titus (1984) also supports the population replacement hypothesis, revealing higher frequencies of certain nonmetric cranial traits in early populations, as well as a change in cranial shape through time.

Three hypotheses of population replacement on the southern islands have been proposed/are found in the literature (Howard and Raab 1993, Martz 1994), but none are clearly supported by recent archaeological data. The purpose of this research is to test these hypotheses through the analysis of a large sample of human skeletal remains. Our research focuses on the temporal distribution of a suite of skeletal traits with high heritability as well as incorporating a considerable sample of cranial metric data.

Analyses of human skeletal remains from two of the southern Channel Islands (San Nicolas and San Clemente islands), as well as from northern Channel populations reveal a more complex interaction between groups than has been previously realized. Our data suggest that the demographic history of the southern Channel Islands is characterized by genetic input from several different island and mainland populations. These findings will result in a reevaluation of previously proposed hypotheses of island-island and island-mainland interaction.

The sexual division of labour in humans: a comparative analysis. C.A. KEY, University College London, UK.

This paper examines the sexual division of labour in humans, with respect to sex differences in activity budgets in non-human primates. Activity budget and

body mass data were collected for males and females of 21 non-human primate species. Using Coelho's (1974) energetic model, these data were used to calculate daily energy expenditure (DEE) for males and females of each species. It was found that across non-human primates sex differences in daily energy expenditure are largely determined by sexual dimorphism in body size. In very sexually dimorphic species (e.g. the gorilla) male DEE is considerably greater than female DEE. In contrast, in monomorphic species (e.g. gibbons) male and female DEE are very similar. Since humans have low sexual dimorphism in body mass, male and female DEE are expected to be similar.

There is a very close relationship between DEE and body mass across non-human primates ( $r^2 = 0.98$ ). On this basis, the expected DEE for human populations can be calculated if body masses are known. Expected and observed DEE were compared for males and females of 13 human populations. It was found that, contrary to expectations, male DEE is considerably greater than female DEE. While human females expend the amount of energy per day that would be expected for a primate of their body size, human males expend significantly more energy per day than would be expected on this basis ( $p < 0.01$ ). This sex difference in DEE, and the particularly high male energy expenditure, is likely to be due to the sexual division of labour in humans. Human males tend to participate in more strenuous activities than females, such as hunting and garden labour. Since high energy expenditure in females may lead to reduced fertility, it is possible that females are unable to engage in these energetically costly tasks themselves. By taking on these activities, males reduce the energetic stress on females. Over the course of human evolution, energetic demands on females are likely to have increased due to the costs of producing large brained offspring with extended childhood periods. The sexual division of labour may have evolved as a response to these high female energetic costs.

Autosomal DNA haplotype diversity within and among Amerind-speaking populations. J.R. KIDD and K.K. KIDD, Department of Genetics, Yale University School of Medicine, New Haven, CT 06520.

Our lab is accumulating data for many nuclear polymorphisms on a set of 8 Amerind-speaking populations as well as many Asian, European, and African populations. All types of nuclear polymorphisms are being studied: STRPs, SNPs, ins/dels, and haplotypes variously composed of markers of all types. Genetic distance analyses show that all Amerind-speakers cluster together, all Asian populations cluster together, and all African populations cluster together; European populations cluster between the African and the Asian and New World clusters.

For one set of 12 loci, half of which are multiallelic haplotypes, the average heterozygosity among 8 Amerind-speaking populations was about 5% lower than that among 7 East Asian populations. For a set of

94 STRP loci on a much smaller number of populations, the Amerind-speaking populations have lower heterozygosity and fewer alleles than the Asian populations, but even the smallest average heterozygosity was nearly 60%, while the East Asians had heterozygosities just over 70%.

At the multiallelic loci--haplotypes and STRPs--the Amerind-speakers have (with few exceptions) a subset of the alleles seen in Europe and East Asia, but it is the same subset in all Amerind-speaking populations. Some of the "exceptions" support a single origin of all these populations because they all share a specific allele that is rare to absent in East Asian populations. There is clearly common ancestry among these Amerind-speaking groups, distinct from that of any Asian population we have studied; associated with that is evidence for a founder effect. However, the overall decrease in genetic variation is not large enough that we would apply the term *bottleneck*.

This research was supported in part by NSF grant SBR-9632509.

Variation at candidate genes for mental disorders.  
K.K. KIDD, Department of Genetics, Yale University,  
New Haven, CT 06520-8005

It is clear that no single locus is likely to be causal for any neuropsychiatric disorder. However, many known genes have functions that make them plausible candidates for an etiologic role in many such disorders. We are studying the normal variation at such loci and find functional variation to be common at several of them. At the dopamine D4 receptor locus (DRD4) we find expressed variation (amino acid sequence differences) in every population studied and find that the predominant form of the receptor differs significantly by region of the world. We have shown that a null allele (no receptor produced) that is found only in populations of Northern European ancestry reaches frequencies of up to 4%. Though this allele is uncommon, that could be medically significant in those populations. At the catechol-O-methyl transferase locus (COMT) two different forms of the enzyme have different activity levels but both exist at common frequencies in all 28 populations studied. The two alleles are almost equally frequent in Northern European populations but in most of the rest of the world the high activity allele is more common (60%-90%). At several other candidate genes studied for multiple polymorphic sites (both functional and neutral) we generally find significantly higher linkage disequilibrium and significantly fewer haplotypes in non-African than in African populations. The patterns seen at most loci fit models of random drift in an Out-of-Africa context with a significant founder effect associated with the migration out of Africa. The allele frequency patterns among populations do not correspond to frequency patterns for mental illness. While these data argue for extensive genetic variation in neural function, all of that variation appears to be in the normal range.

Modern human origins and extant modern humans: an uneasy fit? J. H. KIDDER University of Tennessee,  
Knoxville TN 37996-0720

The Multiregional Evolution Model (MRE) of modern human origins, as put forth by Wolpoff and others (Wolpoff, 1989a,b, 1992; Wolpoff, Wu and Thorne, 1984), suggests that the origin of modern humans is a regional phenomenon, and that regional trait complexes developed across the Old World linking these early moderns to extant regional populations. This predicts that early modern human fossils from a particular region should be closer (distancewise) to extant moderns from that region than elsewhere. Conversely, the Recent African Evolution model (RAE), as promoted by Stringer and others (Cann, 1988, 1992; Stringer, 1988; Stringer and Andrews, 1988), postulates that the earliest modern humans are sub-Saharan in origin and that they replaced the archaic humans they encountered. This, in turn, predicts that the earliest moderns outside of Africa will be closer distancewise to extant moderns from Africa.

Using 93 fossils pertinent to this question and the W. W. Howells modern human database as a referent, randomization techniques are employed and Mahalanobis Distances are calculated from fossils to regional population centroids to determine if the fossil humans from different parts of the Old World can be allied with corresponding regional populations within the Howells sample.

The results of this study show that if regional trait complexes exist, the vast majority of early modern *Homo sapiens* fossils cannot be allied with them in any meaningful way. What is found, instead, is an almost random pattern of associations between fossils and regional population centroids. Additionally, it was found that the extant regional samples are more similar morphometrically to each other than any are to the fossils, themselves. These results, therefore, do not appear to support either a strict MRE or RAE model of modern human origins and call into question the appropriateness of using the modern human sample to address this issue.

Power determinations for ancestral haplotypes in genome scanning for mapping of disease genes. M. KIMMEL, Statistics, Rice University, Houston, TX 77251 and R. CHAKRABORTY, Human Genetics Center, University of Texas at Houston, Houston, TX 77030.

One of the methods of mapping genes of hereditary diseases involves seeking linkage disequilibrium with marker loci spaced evenly throughout the genome, in the subpopulation of disease chromosomes. The rationale for this method is that the disease mutation arises on the background of a given (ancestral) haplotype, which then is only gradually modified by recombinations. For markers located close to the disease locus, this process is slow so that the frequency of the ancestral haplotype dominates even after a large number of generations following the disease mutation. In this study, a mathematical model of the linkage disequilibrium is employed to find the power defined as the probability of the ancestral haplotype being preserved in a given fraction of disease chromosomes. Parameters assumed are the age of disease mutation, the rate of spread of disease chromosomes and the recombination fraction between the disease and marker locus. The multitype Galton-Watson branching process with Poisson progeny distributions is used to

approximate the effects of genetic drift and recombination for the relatively rare disease chromosomes. Preliminary results demonstrate that the power is most sensitive to variability in the age of disease mutation and the recombination fraction between disease and marker loci, and much less sensitive to the rate of spread of disease chromosomes or sample size. For example, if the ancestral haplotype is to exist on at least 30% of disease chromosomes, and the recombination fraction is equal to 0.01, then the power is about 0.8 for a disease 100 generations old, but it is close to 0 for a disease 200 generations old. For the recombination fraction of 0.005, the respective power values are 1 and 0.9. (Supported by US Public Health Service research grants GM 41399 and GM 58545 from the National Institutes of Health.)

Interpreting growth patterns in juveniles: current theories for past populations. S.E. KING, Department of Biological Anthropology, University of Cambridge, UK, and S.J. ULJASZEK, Institute of Biological Anthropology, University of Oxford, UK.

Patterns of growth faltering in past populations have sometimes been attributed to either nutrition or infection, or both. Indeed, human growth is an outcome of complex interactions between genes and the environment, of which nutrition and infection are usually the most important components. Current paradigms in the nutritional literature emphasize the importance of the *interactions* between nutrition and infection in growth disruption. These ideas are based on detailed investigations of nutrition, infection, immunology and pathology among children in developing countries.

New light may be shed on growth faltering in archaeological assemblages by applying the nutrition-infection interactions model, especially in contexts where respiratory and diarrheal diseases may have been endemic. Given that nutrition and infection are inter-related, and can influence growth in complex ways, interpretations should be shifted away from models which dichotomize nutrition and infection as alternate causes. Contemporary studies of malnutrition and infection in children also show how the age at which growth faltering occurs is important to interpretations. For instance, the immunological and nutritional consequences of breastfeeding make interpretations of growth faltering below 6 months of age different than above that age. This model also highlights the limitations of using paleopathological evidence to support interpretations weighted on either nutrition or infection.

Genetic variation and affinities in the New York burial ground of enslaved Africans. R.A. KITTLES<sup>1</sup>, G. MORRIS<sup>1</sup>, M. GEORGE<sup>1</sup>, G. DUNSTON<sup>1</sup>, M. MACK<sup>1</sup>, F.L.C. JACKSON<sup>2</sup>, S.O.Y. KEITA<sup>3</sup>, and M. BLAKEY<sup>1</sup>, <sup>1</sup>Howard University, Washington, DC 20060; <sup>2</sup>University of Maryland, College Park, Maryland 20742; and <sup>3</sup>Oxford University, Oxford, UK.

The New York African Burial Ground is one of the most important archeological sites in America since it contains the earliest and largest skeletal population of ancestral African Americans to be examined through careful archeological excavation. Following its discovery in New York City, archeologists excavated over 400 skeletal remains and associated artifacts, primarily of Africans who died during enslavement.

While many genetic studies have examined levels of genetic diversity and admixture in present African American populations, the extent to which patterns of genetic variation for African Americans resemble ancestral African populations is unknown. Here we search for genetic origins of the skeletal remains by examining mitochondrial DNA control region sequences from 40 individuals from the burial ground. mtDNA sequences were compared to published data from African populations. In order to determine levels of gene flow from non-African populations, sequence data from European and Native American populations were also used for comparative purposes.

DNA was extracted from bone samples using a silica based method. Following PCR amplification of short overlapping regions of segment I of the mtDNA control region, the products were sequenced using an ABI 377 DNA sequencer. High mtDNA diversity was observed indicating that this sample was consistent with other samples of African origin. Phylogenetic analysis revealed that 38 of the mtDNA haplotypes clustered with West African sequences. The ancestry of the two remaining sequences is still being evaluated.

Recently, we have successfully genotyped several autosomal microsatellite loci from many of these samples. These markers will continue to be typed in order to evaluate potential genetic contributions to health and disease. To date, data on the biological history of enslaved Africans is very limited. This genetic study represents a vital link to the archeological, and historical efforts to identify populations which have contributed to the African American experience and ultimately will increase our understanding of the biological history of enslaved Africans and their descendants in the Americas.

Transverse Tooth Movements during Mastication in *Pan troglodytes*. P. J. KLEIN, C. E. WALL, and D. SCHMITT, Dept. of Biological Anthropology & Anatomy, Duke University Medical Center, Durham NC 27710.

Transverse movement of the mandibular teeth is an important component of mastication that occurs during the power stroke, and the balancing-side deep masseter is an important contributor to the transverse motion of the working-side teeth toward the balancing side during the power stroke (Hylander and Johnson, 1994). We hypothesize that the amount of transverse tooth movement should



increase during a chewing sequence due in part to the transition from puncture-crushing to grinding that occurs during a sequence and in part to changes in the material properties of the food bolus during a sequence.

To quantitatively evaluate the presence of this trend, frontal view cineradiographic film of a subadult *Pan troglodytes* female chewing pieces of apple with skin was digitized and analyzed using Peak Performance software. The transverse motion of a marker on the lower left canine was measured relative to a marker on the upper left canine in successive power strokes of a chewing sequence. EMGs recorded for the right and left deep and superficial masseters of the same subject during separate experiments were digitized to determine the relative time of offset of each muscle during chewing of apple with skin.

The cineradiographic data show gradual and then dramatic increases in transverse tooth movement during a chewing sequence (from 1-2 mm in the early chews to 11-12 mm in the late chews of the sequence). In addition, changes in the offset time of the balancing-side deep masseter muscle are very highly correlated with this movement pattern. Other muscles that are potentially involved in transverse tooth movement and the potential involvement of other forces should be the object of further study.

Research supported by NSF DBS-9215072 & SBR-9806291, the LSB Leakey Foundation, and NIH DE05663.

Dawkins Revisited: A reintroduction of multilevel selection theory to the anthropological sciences. K.M. KNIFFIN and D.S. WILSON, Anthropology and Biological Sciences, SUNY-Binghamton, NY 13902-6000.

"Selfish gene theory," as described by Dawkins (1976), proposes that genes comprise the only level of life on which selection operates. Dawkins's works, however, are often misinterpreted by those who accept them as orthodox evolutionary theory.

Specifically, in the context of "group selection" debates, it is often the case that anthropologists attack the use of groups as lacking parsimony. Instead, these anthropologists ask pointedly whether or not something is better explained at the level of the individual. This point, it needs to be made clear, is not consistent with Dawkins's picture of evolution. To these anthropologists, Dawkins would call for explanations at the level of the gene.

This confusion over levels of selection

is not restricted to groups of anthropologists, of course. In fact, we argue that even Dawkins's own texts provide cases where levels of selection are confused.

The framework offered by multilevel selection theory (e.g., Sober and Wilson 1998; Wilson 1998) is an attempt to ground these debates into a clear and coherent set of questions. Such a framework is not only relevant to anthropologists studying evolutionary theory, but also will help inform empirical works regarding human evolution.

Population profiles of Native American genetic diversity based on pooled DNA samples. J.A. KNOWLES<sup>1</sup>, M.H. CRAWFORD<sup>2</sup>, J. MCCOMB<sup>2</sup>, and P. BANERJEE<sup>1</sup>

<sup>1</sup>Department of Psychiatry/Columbia Genome Center, Columbia University, New York and <sup>2</sup>Department of Anthropology, University of Kansas, Lawrence, KS 66045.

An assortment of molecular genetic methods and markers have been applied to the question of origin of Native Americans. Different types of DNA (mtDNA, STRs, VNTRs) reconstruct the peopling of the Americas in different ways. For example, mtDNA is suggestive of Mongols and Amerindians sharing common ancestry. Most of these methods are based on a single locus or on a few loci located on several chromosomes.

It has shown that the allelic frequencies of a microsatellite marker in a group of individuals can be estimated by a single PCR amplification reaction of an equimolar mixture of DNA from each member. The frequency of each allele is then proportional to its percentage of the total amplification products of the pooled DNA. This method can greatly reduce the amount of genotyping required to determine the allelic frequencies of markers in populations. We are applying this technique of DNA pooling to determine the allelic frequencies of 377 microsatellite markers, spaced across the human genome. Each of the 377 markers has been labeled with fluorescent tags and grouped into 37 "panels," co-electrophoresed and detected on an ABI DNA sequencer. The allelic frequencies of a set of markers, evenly spaced across the entire genome, are being calculated for Native American and Siberian populations. This methodology is being applied to the reconstruction of the migrations across Beringia and the patterns of peopling of the Americas.

Maternal blood lead levels and infant birthweight. K.L. KNUTSON, Department of Anthropology, University at Albany, SUNY, Albany NY 12222

Birthweight is a valuable indicator of the health status of the infant and the conditions of the uterine environment.

This report presents an analysis of preliminary data from an on-going longitudinal study designed to assess the effect of lead exposure on human growth and development. Previously, high neonatal lead levels were associated with low birthweights in this sample; here the focus is on the effect of maternal lead levels. The sample is drawn from women seeking prenatal care from two clinics that serve low income residents of Albany, NY. There are 176 women who have measurements for the third trimester blood lead level and birthweight. Multivariate linear regression models are computed with birthweight as the outcome variable. After adjusting for the variables correlated statistically with birthweight and others known to affect birthweight, the individual measurements of lead in the three different trimesters do not have a statistically significant effect on birthweight. The change in maternal blood lead level between trimesters is also examined. The change in blood lead level from the second to the third trimester has a beta coefficient of  $-135.508$  ( $p=0.09$ ).

In this sample, maternal blood lead levels in the three separate trimesters averages 2.01-2.20  $\mu\text{g}/\text{dl}$ , well below the CDC defined level of elevated blood lead of 10  $\mu\text{g}/\text{dl}$ . Possible reasons no relationship is found between maternal blood lead and birthweight would include the small sample size, the low maternal blood lead levels, or the use of maternal rather than neonatal blood lead levels to represent fetal exposure.

Despite the absence of a strong statistically significant relationship between maternal blood lead and birthweight, further analysis will be conducted when the data collection is complete.

Support for this study was received from NIEHS R01-ES 05280.

Morphological integration of craniofacial and dental dimensions in North American and Australian Aboriginal populations. L. A. P. KOHN, Washington University, St. Louis, MO 63108, R. H. OSBORNE, University of Wisconsin, Madison, WI 53706 AND G. TOWNSEND, University of Adelaide, Adelaide, Australia.

Functionally and developmentally related traits are expected to be highly correlated. Population differences in these observed correlations will be due to genetic and environmental differences between populations. We examine phenotypic, genetic and environmental patterns of correlations among craniofacial and dental traits in North American twins and Australian Aborigines to test integration of observed traits within a population and similarity of integration patterns across populations.

Six craniofacial and 12 dental traits were

measured in North American twins and siblings (79 MZ twin pairs, 84 DZ twin pairs, 78 siblings) and 106 Australian Aborigines (including full- and half-sibling families). Maximum likelihood methods were used to estimate trait heritability, as well as bivariate phenotypic, genetic and environmental correlations among traits. We test for significant craniofacial and dental morphological integration within each population, and we test for similar intercorrelation patterns across populations.

There is significant phenotypic integration among dental traits, however there is not significant phenotypic integration among craniofacial traits. Significantly similar patterns are observed in these distinct populations. The genetic patterns of integration provide an understanding of the underlying basis of morphological integration. Similar correlation patterns in these genetically distinct populations suggest universal patterns of craniofacial and dental variation.

Reevaluation of component approaches to age estimation from the human pubic symphysis. L.W. KONIGSBERG, N.P. HERRMANN, and D.J. WESCOTT, Department of Anthropology, University of Tennessee, Knoxville, TN 37996-0720.

McKern and Stewart (1957) and Gilbert and McKern (1973) developed component-based approaches for age estimation from the human male and female pubic symphyseal surfaces. Neither method has ever been extensively evaluated using a known age sample or modern statistical methods. In this study we use a trivariate cumulative probit to evaluate both methods on a large sample of known age individuals.

The data used in this study consist of component scores for the dorsal demi-face, ventral demi-face, and "rim" taken on 765 males and 484 females. The males are from McKern and Stewart's Korean War Dead sample ( $n = 344$ ) and the Terry Collection ( $n = 421$ ), while the females are from Gilbert and McKern's sample ( $n = 156$ ) and the Terry Collection ( $n = 328$ ). We fit the cumulative probit using age on a logarithmic scale so that the variance term for moving between stages within each component reflects increasing variance in the ages at which individuals move to higher numbered stages.

The results show that despite the original researchers' efforts to pick components that are relatively independent, there are substantial correlations within both sexes between the components. In males the correlations between components I and II, I and III, and II and III are 0.77, 0.77, and 0.85 (respectively), while the comparable correlations in females are 0.76, 0.77, and 0.92. These correlations exist despite the fact that age has been "regressed-out" in the probit analyses. Because of the high correlations, confidence intervals for age-at-death can be substantial. We consequently compare both methods to the more traditional phase-based approaches first suggested by Todd.

Supported by NSF-SBR9727386.

Dental pathology and anthropology of Cephalonians at the Roman site of Fiskardo, Greece. A. KONSTANTATOS, Department of Anthropology, Arizona State University, Tempe, AZ 85287-2402.

The site of Fiskardo is located at the northern tip of the island of Cephalonia, Greece, and was a major commercial hub of the Mediterranean basin in antiquity. In a preliminary study of health and disease patterns in the Roman-period population of Fiskardo (150 B.C./B.C.E. - A.D. 400), 77 skeletons excavated from three large graves were systematically analyzed. Following cleaning, stabilization, and reconstruction, the remains were examined to determine various aspects of demography, paleopathology and techno-economic correlates, such as diet.

Destructive commingling in antiquity and postmortem taphonomic conditions severely impacted the skeletal remains, particularly the postcranial remains. Thus, the study was limited to cranial and dental structures. The 66 individuals (59 adults and 7 sub-adults) with dental remains in this collection suffered from relatively fewer and minor degrees of dental pathologies (e.g., caries, LEH, periodontal disease, etc.) and lower dental attrition rates than contemporaneous and non-contemporaneous populations from other regions of Greece and the Roman world (e.g., approximately 25% of all teeth at Lerna had some dental pathology (Angel, 1971)). Possible implications of these findings include evidence for good overall health care at this site, as well as a higher dependency on meat products due to a lack of availability of other environmental resources.

Access to this collection was made possible by members of the ST<sup>+</sup> Ephorate of Prehistoric and Classical Antiquities Agency of Greece, and was supported by grants from the Cephalonian Society of America, the Athanasiades Cultural Foundation, Mr. A. Meimaris, and Arizona State University.

Determinants of the variation of maxillary sinus size in Japanese macaques. T. KOPPE<sup>1</sup>, T.C. RAE<sup>2</sup>, and S. MARQUEZ<sup>3</sup>. <sup>1</sup>Inst of Anatomy, Univ of Greifswald, Germany, <sup>2</sup>Dept of Anthropology, Univ of Durham, Durham DH1 3HN, UK, <sup>3</sup>Dept of Cell Biology and Anatomy, Mount Sinai School of Medicine, New York, NY 10029.

While recent research indicates that maxillary sinus volume (MSV) of those members of the *Macaca fascicularis* species group that inhabit temperate regions seem to respond to cold stress (Rae et. al., 1997, Am. J. Phys. Anthropol., Suppl. 24: 190-191), the exact nature of this relationship is still uncertain. Thus, this study explores the relationship between latitude and MSV in six groups of *M. fuscata* from known localities, ranging from the sub-tropical Yakushima island (30°30'N) to the cool-temperate Shimokita peninsula of northern Honshu (41°31'N).

MSV, obtained from serial coronal CT scans of adult female and male crania from these groups ( $n = 46$ ), was regressed against latitude and average January temperatures. In addition, the size of the nasal cavity was also measured. Due to the condition of the crania, however, the area of the nasal cavity (NCA) was obtained from CT scans at defined positions.

Results suggest that the size of both the maxillary sinus and the nasal cavity are significantly correlated with latitude and average January temperatures. Whereas MSV decreases in northern latitude under cold stress, NCA shows an opposite tendency. Because the regression analysis also revealed that MSV decreases with increasing NCA, it is most likely that the reduction in MSV under cold stress is related in part to modifications in the morphology of the nasal cavity. The large geographic range of *M. fuscata*, however, encompasses variation not only in climate, but in the nutritional content and consistency of the diet, as well (Nakagawa, 1997, Am. J. Primatol. 41: 267-288), which requires further examination. Nevertheless, the results indicate that a significant contribution of the maxillary sinus on the conditioning of the inspired air remains to be adequately explained.

Femora of *Anapithecus* from Rudabánya. L. KORDOS, The Geological Museum of Hungary, H-1143 Budapest, Stefánia út 14, and D.R. BEGUN, University of Toronto, Toronto, ON, M5S 3G3, Canada.

The 1998 excavations of the late Miocene locality of Rudabánya led to the discovery of numerous primate fossils including the associated femoral remains of an adult *Anapithecus*. The left femur is nearly complete, lacking only the distal end, while the right side specimen preserves the proximal end and about 5 cm of shaft. *Anapithecus* is well known from Rudabánya, being represented by over 200 teeth and a small number of phalanges. These femora are the first long bones to have been recovered for this catarrhine. Though damaged, both specimens reveal numerous details of the femoral anatomy of this taxon. RUD 184 is similar in overall length to the femur of *Epipliopithecus vindobonensis* from Slovakia. However, in contrast to the femur of *Epipliopithecus*, RUD 184 has a large and almost perfectly spherical head, a very long, antero-posteriorly compressed neck and a robust, curved shaft with a pronounced gluteal line. RUD 184 is also much smaller and morphologically distinct from the catarrhine femur from Eppelsheim, Germany. This specimen is morphologically very similar to *Epipliopithecus* but from a much larger individual. The morphology of RUD 184 and RUD 183, the more fragmentary specimen, reveal much new information on the positional behavior of *Anapithecus*, and have taxonomic and phylogenetic implications as well. Their overall size suggests an individual larger than *Epipliopithecus*, which is consistent with the *Anapithecus* dental remains. The functional anatomy suggests more strongly developed suspensory positional behavior compared to *Epipliopithecus*, and the amount of morphological distinctiveness calls into serious question previous suggestions of the pliopithecoid status of *Anapithecus*.

This work supported by grants from NSERC, Wenner-Gren and OTA.

Exploring the Relation Between muscle insertion Dimensions and Tooth Use. RICHARD T. KORITZER and LUCILE E. St. HOYME, Dept. of Anthropology, Smithsonian Institution.

This study is an initial attempt to show association between bony ridge dimensions at the medial pterygoid muscle, mandibular insertion and lower canine to third molar size. While the entire insertion area has been assessed for muscle mass representation in the past, the individual bone ridges have not been measured as a componential series. Ridges may vary in number from as few as four to as many as ten or more. The anterior and posterior ridges are smaller and the more central are usually longer, wider and more exophytic. The lateral, medial pterygoid head contributes the anterior ridges and the stylomandibular ligament-muscle (including variable separate slips) influence the most posterior ridges. The robust central ridges represent the portion of medial pterygoid emanating from the pterygoid fossa lateral plate and fossa base. These muscle related ridges play like piano rhythms patterning in componential functions rather than as simple mass action. We have measured ridge length, width and height and dental mesiodistal buccolingual and crown height. Tooth and ridge dimension relation is a proportion of ridge 'force' and dental 'mass'. Sided habitual use (working and balancing sides) are identified. Age/sex variation is found. Diet and other cultural patterns are seen. The absence of associations may also be diagnostic. How has the piano been played in the life of the individual? Graphic evidence can be examined and compared using this model.

Size matters: Assessing the effect of variation in segment parameters on bipedal locomotor energetics. P.A. KRAMER, Dept. of Anthropology, University of Washington, MS 353100, Seattle, WA 98195.

The evolution of hominid bipedality has been an area of acrimonious debate throughout the later half of this century and, as the century draws to a close, little resolution of even the most basic questions seems in sight. Indeed, the complexity of the issues seems to be growing with multiple forms of australopithecine bipedality now a possibility. Nonetheless, bipedality is the ubiquitous characteristic of the *Hominidae* and as such, it is imperative that we grasp its adaptive significance and functional implications.

One critical issue in understanding the evolution of bipedality is understanding how limb segment parameters affect the amount of energy that a biped uses in locomoting.

In a previous report, I introduced a dynamic model which uses rigid links to represent body segments and which can be used to calculate total energy required to locomote at a given velocity. I showed that segment length affects total energy use in potentially counter-intuitive ways. A configuration based on AL 288-1 (*Australopithecus afarensis*) is more energetically efficient than one developed from a composite modern human female.

I, now, extend the research and evaluate the effect of modifying inter- and intra-segmental mass distributions. I vary the percent of total body mass present in each segment and the distribution of mass along the segment's length and about its cross section using data from modern humans and chimpanzees (*Pan troglodytes*). I show that my previous conclusion holds for mass distributions that resemble chimpanzees as well as for those that represent modern humans. Relatively short legs are appropriate for a biped whose locomotor regime can accommodate slow walking speeds and small day ranges.

AL 288-1 and, presumably, her conspecifics were elegantly adapted for an ecological niche that allowed them to utilize slow speed bipedality and a limited day range. Their relatively short legs were neither a compromise nor transitional, but rather, an integral component of their locomotor form.

Infant diseases in Central Europe during the Early Middle Ages. - K. KREUTZ, Institute of Applied Forensic Anthropology, Remagen. G. TEICHMANN, Center of General Surgery, University of Göttingen. and M. SCHULTZ, Center of Anatomy, University of Göttingen (Germany).

After the decline of the Roman Empire, the situation of the population from a demographic point of view and living conditions changed completely in Central Europe and during the Early Middle Ages, new conditions developed. Since childhood diseases provide a reliable scale by which to determine population health (Schultz 1994) a total of 349 skeletons of subadults excavated at four sites in southern Germany and Austria were examined. These investigations were carried out by macroscopic, radiological, endoscopic, light and scanning-electron microscopic techniques to study the change in population health during the Early Middle Ages: 1) Straubing (n=198) and 2) Peigen (n=50), both populations from Lower Bavaria, 5<sup>th</sup> - 7<sup>th</sup> century AD, 3) Grafendobrach (n=69), Frankonia, and 4) Pitten (n=32), Lower Austria, both populations 8<sup>th</sup> - 9<sup>th</sup> century AD.

Vestiges of infectious diseases (e.g. bacterial meningitis) were much more frequently diagnosed than changes caused by deficiency diseases such as scurvy and/or rickets. It is striking that inflammatory processes of the middle ear region, the nose cavity and the paranasal sinuses were significantly more frequently observed in infants younger than six years than in older children. However, the frequencies of inflammatory/hemorrhagic meningeal reactions were relatively low in comparison to late medieval and early modern European populations.

The results show that there were probably no basic significant differences between the health state in early medieval Germanic populations from the geographic area of southern Germany and Austria.



Isotopes and teeth: a comparative study of prehistoric foraging populations from tropical Southeast Asia. J.S. KRIGBAUM, Department of Anthropology, New York University, New York, NY 10003.

It has been proposed that the scarcity of starchy foods in Southeast Asian rain forests represents the major limiting resource affecting human foraging populations in those regions. This observation, combined with data from Amazonia and Central Africa, have led others to claim that rain forest occupation worldwide is a post-agricultural phenomenon (e.g., Bailey *et al.*, 1989). It is presumed that without carbohydrate supplements from neighboring agriculturalists, hunter-gatherers simply could not have survived for the long-term in the rain forest and were therefore restricted to fringe and coastal environments.

The present study uses prehistoric human remains as a means to elucidate "broad spectrum" subsistence patterns germane to this issue. Gua Cha (Kelantan, W. Malaysia) and Niah Cave (Sarawak, E. Malaysia) are situated in primary rain forest and have yielded Holocene pre-Neolithic (pre-agricultural) and Neolithic contexts. Inter-site differences in stable isotope values, caries frequency, and wear rate demonstrate two distinctly different "broad spectrum" foraging patterns. These differences in isotopic and dental results are mirrored in differences of local site ecology. Gua Cha is an inland habitation site, situated in the center of Peninsular Malaysia, far from the coast (ca. 150 km). Bailey *et al.* (1989:71) do note that the site of Gua Cha demonstrates strong evidence contrary to their universal rain forest habitation hypothesis. Niah Cave, in contrast, is only a short distance from the coast (ca. 16 km), and would have been more fringe rain forest habitat, where coastal food resources were more readily available during mid-late Holocene times. Results demonstrate that paleodietary signals are useful to gauge ecological and dietary differences between foragers inhabiting different rain forest habitats.

Supported by grants from the Wenner-Gren Foundation and the National Science Foundation.

#### ARTICULAR SCALING IN THE HOMINOID TALOCRURAL JOINT: THE COMPROMISE BETWEEN BODY SIZE AND LOCOMOTION. M KRIZ, Department of Anthropology, Miami University, Oxford, OH 45056, and Laboratory of Physical Anthropology, Cleveland Museum of Natural History, Cleveland, OH 44106.

Given the avascular nature of synovial cartilage and the physiological constraints placed upon its thickness, it is necessary for joints to have alternative methods of dissipating potentially damaging interarticular loads. Similarly, the negligible frictional forces ( $\mu=0.002-0.02$ ) within a healthy synovial joint require that major transarticular loads must be directed normally to the chondrum. The size and shape of African ape and human tali reflect adaptations to such mechanical demands, and the articular morphology of the hominoid talus likely represents a compromise between body size and species-specific locomotor patterns.

In order to test this, the talocrural joints of *Hylobates sp.* (n=10), *Pan troglodytes* (n=29), *Gorilla gorilla* (n=32), *Homo sapiens* (n=78), and *A. afarensis* (AL 288-1) were examined. Variables included surface areas, radii of curvature and subtended angles of the talar trochlea, and articular excursions of the talocrural joint. For purposes of normalization, a skeletal surrogate for body mass was used ((humeral head + femoral head)/2).

Results indicate that radius of curvature increases and subtended angle decreases with increasing body size. This is best displayed in the highly sexually dimorphic species *Gorilla*; male gorillas maintain a markedly larger talar radius of curvature and a smaller subtended angle than their female counterparts. Associated with these alterations is the loss of talocrural excursion. An increase in joint surface area also accompanies increases in body size among the apes.

In humans, radius of curvature increases faster than would be expected indicating a departure from isometry. Humans also have a larger talar trochlear surface area for a given body size. These alterations can be attributed to the large loads concentrated on a single supporting limb during habitual bipedality.

African apes and humans have thus altered the morphology of the talus as a response to increased transarticular loads associated with body size and/or locomotor patterns. In order to accommodate increased peak loads, be they due to increased body size or locomotor alteration, certain obligatory compromises must be made such as loss of joint excursion. An elevation in transarticular loads accompanying an increase in body weight or an altered locomotor pattern results in a flattening (increased radius / decreased subtended angle) of the articular surface. Features of the human talus reflect functional adaptations attributed to a unique bipedal gait. The *A. afarensis* talus investigated in this study shares characteristics similar to modern humans.

Three-Dimensional Analysis of Modern Human and Neandertal Craniofacial Growth Patterns. G.E. KROVITZ, Johns Hopkins University School of Medicine, Baltimore, MD 21205.

Neandertal remains present a relatively complete ontogenetic sequence, providing an important opportunity for detailed comparisons between archaic and modern human craniofacial growth patterns. Growth comparisons between archaic and modern human samples shed light on the evolution of modern human growth patterns and provide a baseline for inferences about craniofacial growth patterns within *Homo*.

This study was designed to document and compare craniofacial growth patterns in Neandertals and seven geographically diverse modern human samples from Asia, Africa, Europe, and North America. Three-dimensional coordinate data were collected for 43 landmarks on the face and neurocranium, and were analyzed using Euclidean Distance Matrix Analysis (EDMA).

Results of this analysis show localized differences in growth of the face and neurocranium between Neandertals and modern humans. Neandertals are experiencing increased growth in maxillary height and prognathism at an earlier age relative to modern human groups. Neandertal adolescent midfacial growth magnitudes are also increased relative to that experienced by modern humans.

A different pattern emerges in the neurocranium. The modern human groups experience increased magnitudes of growth in height and length of the neurocranium at an earlier age relative to the Neandertals. The Neandertals experience this pattern of growth at a slightly older age.

Neandertals also experience a larger amount of growth in the distances that stretch from the face to the external auditory meatus, possibly reflecting lengthening of the middle cranial fossa and cranial base. This lengthening contributes to the distinctive projection of the Neandertal face relative to the neurocranium and basicranium. These localized differences in growth patterns of Neandertals and modern humans demonstrate that a global heterochronic mechanism cannot be used to describe Neandertal growth relative to modern human growth.

Research was supported by the National Science Foundation, the L.S.B. Leakey Foundation, and the Japanese Society for the Promotion of Science.

Vertebral osteophytosis and mechanical stress in apes. K.J. KRUMRINE, Dept. of Anthropology, Kent State University, Kent, OH 44242.

Vertebral osteophytosis is a degenerative arthritic condition of the vertebral bodies common in human populations. It is generally distributed in areas of the spine receiving high amounts of stress, especially the lumbar region and at points of maximum curvature. Much research has focused on its prevalence among archaic human populations, specifically looking at the comparative distribution of osteophytes within the vertebral column between groups. These studies have attempted to link the distribution of osteophytosis to specific patterns of behavior based upon the way in which the patterns of distribution deviate from that expected of bipedal locomotion. Much of this work has been inconclusive.

This study analyzes the distribution of vertebral osteophytosis in apes in order to compare the way in which osteophytosis is expressed in quadrupedal versus bipedal locomotion and, consequently, to better understand the potential causal factors associated with its development. A sample of 88 gorillas, 46 chimpanzees, 13 orangutans, and 40 gibbons were examined for evidence of vertebral osteophytosis. With the exception of the gibbons, which were negative for osteophytosis, the severity of the osteophytes in all groups was greatest in the lumbar region. In gorillas and orangutans, the cervical region had the second most severe osteophytes, while in chimpanzees the thoracic showed the second most severe osteophytes. The gorilla and orangutan patterns are similar to that seen in some human archaic groups, specifically archaic Eastern Woodland groups. The chimpanzee pattern is consistent with the expected pattern for bipeds. Evidence of similar distributions of osteophytosis in humans and apes suggests that locomotion and activity patterns may not be the only causal mechanisms for the development of vertebral osteophytosis.

## AGE-RELATED OSTEOPENIA IN AFRICAN APES AND HUMANS: THE PERILS OF BEING BIPEDAL

CA KUNOS and B LATIMER, Department of Anatomy, Case Western Reserve University and Laboratory of Physical Anthropology, Cleveland Museum of Natural History, Cleveland, OH 44106.

Among mammals, only humans and their immediate ancestors have used a unique and peculiar form of orthograde, striding locomotion—bipedality. Similarly, humans are unusual in their mechanisms for accommodating locomotor loads generated during bipedal gait. Quadrupedal mammals dissipate locomotor loads in the forelimb and hindlimb by contracting muscles eccentrically. As a consequence of bipedality, humans have eliminated totally the forelimb's contribution to the attenuation of locomotor loads. Moreover, eccentric contraction in the single supporting limb is compromised as a result of an extended hip and knee. To attenuate peak loads, humans have expanded the volume of compliant cancellous bone and have reduced subchondral bone thickness within long bones.

Among mammals, only humans demonstrate a significant natural decrease in bone mass with age. Age-related osteopenic changes in bone mass are related to the relative surface area of cortical and cancellous bone surfaces available for resorption. As a consequence, cancellous bone shows larger and more rapid reductions in mass with age. Bones that have large volumes of cancellous bone are subject to the clinical sequelae of osteopenia or osteoporosis. In humans, the vertebral column demonstrates age-related bone mineral density loss. Coincident losses in the calcaneus, distal tibia, proximal femur, and distal radius are also evident. In direct contrast, African apes fail to demonstrate appreciable age-related bone loss in either the axial or appendicular skeleton.

Among aging humans, two primary problems of the musculoskeletal system are apparent. First, the increased relative volume and surface area of cancellous bone in human metaphyses have resulted in the rapid and potentially dangerous onset of age-related osteopenia. Second, losses in bone mass associated with osteopenia have resulted in similarly unique suite of clinical manifestations, many of which are the direct result of anatomical adaptations to habitual bipedality. Demographic changes in modern human populations ensure that the clinical sequelae of osteopenia will increase.

Description of the Gondolin teeth: Hyper-robust hominids in South Africa? KL KUYKENDALL, University of the Witwatersrand, South Africa, and GC CONROY, Washington University, St. Louis, MO.

The Pleistocene fossil locality known as Gondolin is located about 4km SW of the town of Broederstroom in the Northwest Province, South Africa (SA). The site was worked briefly in 1979 by E Vrba, and given a maximum date of approximately 2 million years ago based on the occurrence of the suid *Metridiochoerus andrewsi*.

During a brief testing excavation in November 1997, two fossil hominid teeth were recovered from one of the extensive mining dumps at the site. Both have been identified as 'robust' australopithecine molars, based primarily on their large size. The more complete tooth (a mandibular left permanent M2)

demonstrates moderate, flat occlusal wear, a tuberculum sextum, and interproximal wear facets both mesially and distally. The following analysis focuses on this specimen, which has proven equivocal in its taxonomic affinities, showing some features associated with East African (EA) 'hyper-robust' forms.

For example, the (uncorrected) mesiodistal (18.4 mm) and buccolingual (17.8 mm) diameters are greater than reported means for either SA or EA 'robust' (or gracile) species, and in fact this is the largest permanent M2 recovered from SA. The uncorrected crown base area ( $MD \times BL = 327.52 \text{ mm}^2$ ) is also greater than any other SA specimen (max. reported  $290 \text{ mm}^2$ ), and comparable to EA means. However, the crown shape index ( $(BL/MD) \times 100 = 96.74$ ) is larger than the reported EA maximum and indicates that the tooth is relatively broad buccolingually as in SA 'robust' taxa.

We also report on results from more detailed morphological study, CT imagery, and SEM analysis in an attempt to fully characterise these hominid teeth.

Leaving aside the varied and controversial issues in robust australopithecine systematics, the two most likely alternative taxonomic interpretations for the Gondolin M2 are that: a) it is an unusually large SA specimen, belonging to either *P. robustus* or *P. crassidens*; or possibly b) it represents an extreme southern population of an EA 'hyper-robust' taxon such as *P. boisei*. More conclusive statements await recovery of additional and more complete specimens from this site.

A comparative study of the size and shape of the Taung Child: An immature *Australopithecus africanus*. PELAJI S. KYAUKA, Division of Behavioral Sciences, Modesto College, 435 College Avenue, Modesto, CA 95350.

Anatomical data pertaining to the face of the Taung child, an immature hominid attributed to *Australopithecus africanus* (Dart 1925) has increased dramatically in the past seventy years (Kyauka, 1994), however, issues concerning the size and shape of its face are still of research interest because of their phylogenetic and ontogenetic implications.

The purpose of this study is to assess the size and shape of the face of the Taung child relative to those of *Pan troglodytes*, *Pan paniscus* and *Gorilla gorilla*. To achieve the objective, facial measurements and indices for the Taung child were compared with similar measurements and indices for *Gorilla*, *Pan troglodytes*, and *Pan paniscus* at similar stages of dental development. The comparative specimens used in this study *Pan troglodytes* (n = 11), *Pan paniscus* (n = 6) and *Gorilla gorilla* (n = 12) were all collected in the wild.

The results show that proportionally, the face of the Taung child has a pattern that is different from those of *Pan troglodytes*, *Pan paniscus* and *Gorilla gorilla* at similar stages of dental development. Despite retention of

anatomical features reminiscent of *Pan troglodytes*, *Pan paniscus* and *Gorilla gorilla*, the data suggest that the face of the Taung child appears to have attained a distinct form.

An assessment of nutritional stress in the skeletons of South African whites and blacks. E. N. L'ABBÉ, Louisiana State University, Department of Geography and Anthropology, Baton Rouge, LA 70820, M. Y. İŞCAN and S. R. LOTH, University of Pretoria, Department of Anatomy, Pretoria 0001, South Africa.

Nutritional status is an indication of the success of a population's adaptation to the environment. This status has been assessed through observations of such indicators as dental pathology, deficiency diseases, and even stature. Angel (AJPA 1982:58:297-305) suggested that cranial base height and pelvic depth may also be affected by poor nutrition, mineral inadequacies, and disease. He also stated that while cranial base height and pelvic depth alone are not true indicators of growth efficiency, their correlation with secular change may be.

South Africa has gone through considerable sociopolitical change in the last 100 years and this may have affected the health status of the inhabitants. Thus, the purpose of this paper is to determine what effect conditions had on skeletal indicators in whites and blacks and if these groups were differentially affected. This evaluation was done by measuring femoral length (FL), cranial base height (CBH) and pelvic dimensions (brim height, BH; breadth, BB) in South African whites (37 males; 52 females) and blacks (36 males, 38 females) primarily from the documented Pretoria collection, supplemented with some Dart collection females. Average age at death was about 70 years for males and about a decade less for females. The earliest date of birth (DOB) was 1883. Results indicated that there was no significant correlation between DOB and age with CBH, BH, BB, and FL except in white females who showed a significant correlation between DOB and FL. To control for individual size differences, CBH/FL, BH/FL, BB/FL, and BI (brim index=BH/BB), indices were also correlated against DOB and age, but the results were not significant.

In conclusion, based on these dimensions, this study agrees with others that blacks and whites were differentially affected by local conditions. Furthermore, the apparently minimal change over time or "neutral secular trend" in South Africa, is a stark contrast to the significant size gains reported in many other parts of the world.

Morphometric analysis of hominoid distal femora: an evaluation of the single species hypothesis for Hadar hominids. M.R. LAGUE, Doctoral Program in Anthropological Sciences, SUNY at Stony Brook, Stony Brook, NY 11794-4364.

Previous studies have recognized two patterns of distal femoral morphology among the specimens from Hadar,

Ethiopia assigned to *Australopithecus afarensis*. Size and shape differences between the well-preserved large (AL 333-4) and small (AL 129-1a) distal femora from Hadar have been used to invoke both taxonomic and functional differences within the *A. afarensis* hypodigm. This study reexamines morphometric differences between the above specimens based on observed variation and patterns of sexual dimorphism among extant hominoids.

Eight extant reference populations are sampled to provide a standard by which to consider size and shape differences between the fossils. Samples include modern humans, *Pan troglodytes* (2 subsp.), *Gorilla gorilla* (3 subsp.), *Pan paniscus*, and *Pongo pygmaeus pygmaeus*. For both raw data and scale-free "shape" data (both derived from 2-D coordinate data), all possible pairwise *d* values (average Euclidean distances) are calculated within each reference population using an exact randomization procedure (subspecies pooled). The resulting distributions are used to evaluate the difference (*d* value) between the two fossils. Euclidean Distance Matrix Analysis (EDMA) is used to test whether the pattern of morphological differences characterizing the fossils significantly differs from patterns of sexual dimorphism observed in the eight extant taxa. Overall morphometric affinities of the fossils are explored using canonical variates analysis (CVA).

Results of the randomization procedure indicate that the size difference between the Hadar femora can only be accommodated within the highly size-dimorphic *Pongo* and *Gorilla* samples. The fossil *d* value based on shape data, however, can be sampled safely ( $P > 0.05$ ) within all reference populations. Based on EDMA, the pattern of morphological differences between the fossils does not statistically differ from any pattern of femoral dimorphism observed among living hominoids. Moreover, despite a large size disparity, the two Hadar fossils appear to be more similar to each other than either specimen is to any of the extant hominoid groups.

This study was supported by NSF (SBR9712585).

The hardness of cercopithecine foods: implications for the critical function of enamel thickness in exploiting fallback foods. J.E. LAMBERT, Southwest Missouri State University, Springfield, MO 65804; C.A. CHAPMAN, University of Florida, Gainesville, FL 32611; R.W. WRANGHAM and N. L. CONKLIN-BRITTAIN, Harvard University, Cambridge, MA 02138.

Thick dental enamel is commonly interpreted to be an adaptation to hard food consumption. Indeed, recent data suggest that hard-food consumers have significantly thicker enamel than soft-food consumer counterparts (Dumont, 1995). However, while *Lophocebus albigena* has among the thickest molar enamel seen in extant primates, there exist few quantitative data on whether this species consumes foods that are significantly more resistant to puncture than foods consumed by sympatric species.

In this project, we measured the hardness of foods consumed by sympatric grey-cheeked mangabeys and redtail monkeys (*Lophocebus albigena*; *Cercopithecus ascanius*) to evaluate whether mangabey enamel thickness could be in part a function of dietary mechanical attributes. The study was conducted in Kibale National Park, Uganda. Feeding data were collected in 1997 and food hardness data between 1991 and 1997. Food resistance to puncture and crushing forces was measured

following Kinzey and Norconk (1990). Data on leaf toughness and food availability were also collected.

There was no difference in the toughness of leaves consumed by the two primate species. While these species normally overlap in their fruit diets (23/34 spp; 68% overlap), fruit was scarce during the 1997 season. As such, each turned to alternative foods: redtails ate significantly more insects and leaves, while mangabeys consumed significantly more bark and seeds. There was no difference in dietary hardness when the puncture resistance of all fruit known to be consumed by these two species, regardless of season, were compared ( $U = 301.1$ ;  $p = 0.5$ ). However, in 1997, the mangabeys exploited an overall harder diet than the redtails ( $U = 69.5$ ;  $p = 0.02$ ). This difference is explained largely by the higher percentage of bark and seeds consumed by the mangabeys during this time of low fruit availability.

Our results suggest that enamel thickness may be selected for by the hardness of foods consumed during seasonal shortages of preferred soft-food items (e.g., fruit), rather than those foods consumed most commonly throughout the year. Such a pattern suggests that thick enamel in *Lophocebus* serves a critical function in exploiting foods during seasonally stressful periods.

The epidemiology of treponemal disease in North Carolina and southern Virginia during the 2<sup>nd</sup> millennium A.D. P.M. LAMBERT, Department of Sociology, Social Work and Anthropology, Utah State University, Logan, UT 84322.

The osseous record of treponemal disease in North Carolina and southern Virginia for the last thousand years suggests a complex epidemiological history characterized by variability and change. During the Mississippian period (A.D. 1200-1500), cranial and postcranial lesions consistent with, or pathognomonic of, treponemal disease are most common in individuals from small, northern piedmont villages. Despite demographic predictions, they are less frequent in contemporaneous skeletal series from larger southern piedmont and mountain villages. More puzzling and somewhat paradoxical, however, is the evidence for a significant decline in the frequency of these lesions in both piedmont and mountain regions after A.D. 1500, given that health does not otherwise appear to have improved during the proto-historic and early historic periods. Although some differences in age structure exist between late prehistoric and proto-historic/early historic samples, these differences are not sufficient to explain the magnitude of this decline. Differential preservation could also be a factor, because samples from proto-historic and early historic burials tend to be poorly preserved. However, such a bias cannot account for differences in the relative frequency of lesions unless pathological specimens are more susceptible to decay, and this is not evident elsewhere. These data suggest that a host of environmental and cultural variables were influencing the pathogenicity of treponematoses in indigenous populations of North Carolina and southern Virginia, and that European contact in this region coincided with a decline in at least the skeletal manifestations, if not the absolute prevalence, of the local endemic form of this disease.



Infant diseases in pre-Columbian North American Southeast: the Late Woodland and Mississippian populations from the Piedmont of Virginia and North Carolina. C.S. LARSEN, University of North Carolina, Chapel Hill, NC 27599-3120, M. SCHULTZ, T.H. SCHMIDT-SCHULTZ, University of Göttingen, Germany, P.M. LAMBERT, Utah State University, Logan, UT 84322.

Our understanding of health and disease in the precontact-era American Southeast is largely informed by study of nonspecific stress indicators, with little attention paid to diagnosis of specific diseases. In many settings, health in late prehistoric farming societies was apparently less robust relative to earlier foragers. However, little is known about specific diseases affecting these populations, especially among subadults.

The purpose of this study is to examine and interpret evidence of specific deficiency and inflammatory/infectious diseases in 51 subadult (fetal-19 years) skeletons from late prehistoric sites in the Piedmont region of North Carolina and Virginia. All populations represented were maize farmers, lived in permanent or semi-permanent communities, and post-date A.D. 1200. Skeletons were examined by macroscopic and radiological techniques.

Our analysis indicates frequencies for the following deficiency and inflammatory/infectious diseases: scurvy (16.7%), rickets (3.3%), anemia (3.3%), meningeal reactions (e.g., meningitis, epidural hematoma; 67.6%), osteomyelitis (0.0%), otitis media (13.4%), sinusitis maxillaris (46.7%), parodontitis (90%), and dental caries (41.7%). The overall pattern that emerges from this assessment suggests high frequency of inflammatory conditions (especially meningeal reactions, parodontitis, sinusitis) and low frequency of deficiency diseases. In general, these findings suggest suboptimal living conditions in late prehistory in this setting, consistent with other evidence of health (nonspecific stress indicators).

Forelimb and hind limb angular excursions in primates: which is unique? S. G. LARSON, Dept. of Anatomical Sciences, SUNY Stony Brook, Stony Brook, NY 11794; D. SCHMITT, and C. SIPE, Dept. of Biological Anthropology and Anatomy, Duke University, Durham, NC 27705

It is well recognized that living primates have unusually long stride lengths compared to nonprimates. This characteristic of primate gait has been linked to longer limb bone lengths and higher degrees of angular excursion than would be predicted for their body size. However, while larger forelimb angular excursions have been recently documented for a variety of prosimians, monkeys, and apes (Larson et al. 1998), this phenomenon has only been demonstrated for the hind limb of chimpanzees and spider monkeys (Reynolds, 1987). We

set out to investigate whether hind limb excursion is also large in a sample of Old World monkeys.

Hindlimb kinematics from *P. Anubis*, *E. patas*, *C. aethiops*, *M. mulatta*, *M. fascicularis* were derived from lateral video images of subjects walking along a 6 meter wooden runway. Coordinate data for the hip and point of contact were digitized using Peak Performance Software (Motus 4.0) and excursion angles were calculated as the change in angle from touchdown to liftoff.

Surprisingly, hind limb angular excursions in all species except the baboon were close to those predicted for their body sizes using an equation from McMahon (1975). This is in marked contrast to forelimb angular excursion data presented by Larson et al. (1998) demonstrating significantly larger angles across all primates. Those species that do display unusually large hind limb angular excursions share in common short hind limbs compared to their forelimbs. While this is due to absolute length differences in chimpanzees and spider monkeys, in baboons the difference is postural. Our study indicates that baboons walk with their hind limb joints more flexed than their forelimb joints reducing the effective length of the hind limb. It appears that a shorter hind limb must pass through a larger excursion angle to maintain the same step length as the longer forelimb. While the Old World monkeys we examined do have long stride lengths, for the hind limb this is clearly accomplished mainly by their long limbs.

Supported by NSF Grant SBR 9806291.

Differential maturational delay is evident in girls, but not boys, from a comparative longitudinal study of South African rural versus urban "Cape Coloured" children. M. LAVELLE, University of Rhode Island, Kingston, RI 02881 and M. HENNEBERG, University of Adelaide Medical School, Adelaide, SA 5005, Australia

The hypothesis that males are more sensitive to the effects of environmental stress has been supported by several studies in which boys show greater growth retardation and/or maturational delay than girls experiencing similar conditions of adversity. Few longitudinal studies are available which provide comparable data for testing both growth and maturational responses between sexes in differing environments for the same population.

Longitudinal growth data for 1254 South African "Cape Coloured" children aged 4 - 20 were obtained from urban Cape Town and rural settlements in Klein Karoo. In both rural and urban samples, data on SES and body size were available for an average record length of 5 years. Maturation markers of age at menarche and age at peak height velocity were also calculated for analyses and comparisons between sexes, urban-rural environments and SES.

Results of these analyses show that girls from rural Klein Karoo are delayed by an average of one year in age at PHV (12.47 vs 11.41 yrs) as well as age at menarche (13.32 vs 12.35 yrs) compared with their

urban Cape Town cohorts. However, the few high SES rural girls did not differ from high SES urban girls. Rural boys showed no significant delay in PHV by SES or by region. Both sexes of urban Cape Town children were slightly below NCHS age-specific standards for growth in stature (MeanZ approximately -.45) regardless of SES. Rural children were significantly smaller per age than urban children (Mean Z boys = -1.49; Mean Z girls = -1.31).

In this longitudinal study, differential maturational delay is characteristic of females, rather than males, among rural children demonstrating significant growth retardation in stature. The fact that rural boys exceed rural girls in the degree of statural deficit argues against the explanation of differential favorable treatment of boys versus girls in this population.

Examination of the rare buccal style on human incisors.  
C. LEE, S.E. BURNETT, C.G. TURNER II.  
Department of Anthropology, Arizona State University,  
Tempe, Arizona 85287-2402.

In rare cases, a style or triangular ridge of enamel can occur near the midline of the buccal surface of human incisors. Previously referred to as a facial talon cusp, this feature has been reported on mandibular incisors in two European cases (McNamara, 1997; Schulze, 1997), while a Native American with a maxillary incisor displaying a buccal cusp has also been described (Turner, 1998). Recently, another example was identified in a Native American skeletal sample (n=132) of Caddoan peoples, and three cases were discovered in a series of Pima Indian dental casts. Subsequently, we examined additional Pima Indian dental casts in order to provide new data on the frequency, symmetry, and occurrence of this rare feature.

A large series of dental casts (835 female, 1000 male) from the A.A. Dahlberg Pima collection was examined for the presence of a buccal style on both mandibular and maxillary permanent incisors. Two additional cases, both males, were identified yielding a total frequency of .1%. The extreme rarity of a buccal style on incisor teeth suggests the trait may not be very useful in population comparisons. However, more may be learned by an examination of all nine known cases.

Eight cases affected the mandibular central incisors alone. The remaining case, described by Turner (1998), is interesting in that a maxillary lateral incisor is affected. Four of nine cases were symmetrical in terms of the presence or absence of the trait. Sex of the affected individual was known in eight of nine cases resulting in five male and three female examples. No attempt was made to quantify variation observed in both the size and location of the buccal style.

This preliminary study is the first known presentation of multiple new cases of buccal styles on incisor teeth. We now have some limited data on the frequency of occurrence, symmetry, and sex distribution of this rare trait. Hopefully future research will enable us to better understand the etiology and genetic occurrence of this trait as well as any possible correlations that may relate to other morphological features of the human dentition.

"Levantines and Londoners," Part II: Is the Cranial Variation in the Levant Hominids Just Too Much?  
Sang-Hee LEE, Paleoanthropology Laboratory,  
University of Michigan, Ann Arbor, MI 48109-1382.

Variation in the Levant hominids holds an important place in the problem of modern human origins. The presence of more than one hominid species in Levant implies a recent origin for modern humans and their replacement of the indigenous Neanderthals on the species level. This paper re-examines the question that has been raised by previous researchers: Is the variation observed in the Levant hominids is too much to be expected in a sample of one species?

The null hypothesis tested in this paper is that the variation in Levant hominids is within the range of variation expected in modern humans of diverse ethnic composition (for example, Londoners). To test this hypothesis, cranial measurements were collected from the Hamann-Todd Osteological Collection at the Cleveland Museum of Natural History (n = 91). This sample is selected for the composition of diverse ethnic groups (early 20<sup>th</sup> century Clevelanders).

The conventional statistical tests comparing variance cannot be used to solve this question. In addition to the problems related to the assumptions about the population distributions, the pivotal problem in this case lies in the sample size: the fossil hominid sample size is too small, and the samples compared have unequal sample sizes. Circumventing these problems, this paper uses a method that employs an alternative approach of data resampling.

Results of the analysis show that the null hypothesis cannot be rejected. It is therefore concluded that the variation in Levant hominids is not enough to support the argument of more than one species in the Pleistocene Levant.

Size, scaling, and heterochrony in the genus *Papio*. S.J. LEE, L.S. BUCHANAN, and S.R. LEIGH. Department of Anthropology, University of Illinois, Urbana.

Analyses of ontogenetic allometry provide critical insight into primate adaptations. Specifically, studies of relative growth allow elucidation of the developmental bases of size and shape differences among taxa. This study investigates size and scaling in extant and fossil baboons in order to better-understand the evolutionary and heterochronic significance of shape differences within and among taxa in the genus *Papio*.

Craniometric data from large samples of baboon

subspecies are analyzed. All postnatal age groups are represented in the samples. The primary data for this study include linear dimensions extracted from three dimensional coordinate data. These data are subjected to regression and multivariate analyses in order to evaluate the ontogenetic bases of size and shape differences between sexes and among subspecies. Data from fossil taxa provide information regarding long-term evolutionary changes in scaling relations.

Results indicate that ontogenetic scaling generally accounts for differences in size and shape within species and among subspecies. For example, Anubis baboons can be described as ontogenetically scaled-up versions of smaller forms, such as Kinda baboons. Other baboon subspecies tend to occupy intermediate positions along size and shape trajectories. Positive allometries, especially in facial dimensions, produce substantial shape differences between sexes and among subspecies. Evaluation of limited fossil samples indicates that ontogenetic patterns are conservative within the genus. Moreover, fossil data imply that size increase through hypermorphosis best accounts for the evolution of shape differences within the genus. Exceptions to the general pattern of ontogenetic scaling are illustrated and discussed. The implications of these results for analyses of ecology, behavior, and evolution in baboons are considered.

This research was supported by NSF (SBR 9707361), Wenner-Gren, and the LSB Leakey Foundation.

Towards a bio-anthropology of regulations and adaptations. Ph. LEFEVRE-WITIER, Centred'Immunogénétique humaine - CNRS - Hopital Purpan - Toulouse - France

For thirty years, the study of the relationships between genetics and pathology has demonstrated the importance of environmental variations to reveal the existence and distribution of a large number of mutations.

Other than the now classical genetic « markers », such as blood groups, more and more polymorphisms are discovered ; many concern proteins and especially enzymes dealing with cell metabolism, neuro-hormonal secretions and the complex structures of immune-response. Some examples are provided by recent research on cell growth and multiplication, on apoptotic effects and on antibody production.

These advances in the knowledge of bio-chemical diversity and the resulting selective capacities open new fields for anthropologists and especially research on the variability of physiological regulation and control mechanisms of adaptation. Such a development should be stimulated by the drastic transformations of conditions of life now observed in some populations. Let us mention the climatic and nutritional changes caused by large and long distance migrations, south to north as well as east to west, i.e. from the humid tropics to cold temperate areas, and the stress and pollution by

urban concentrations in many megapolis. Also the *in situ* disappearance of some human ecosystems through modernisation and loss of their traditional production has to be mentioned with a reduction in adaptative bio-diversity as a consequence.

Monitored growth: anthropometrics and health history records at a New England middle school, 1935-1960. LEIDY, L.E. Dept. of Anthropology, UMASS at Amherst, 01003-4805.

Anthropologists are well aware of the synergistic relationship between poor nutrition and infectious disease when examining variation in growth. This paper examines whether or not there is an association between infectious disease and the growth of boys who were given every opportunity for good nourishment.

For 25 years, every boy in attendance at a private New England middle school was monitored for height, weight, and a variety of body circumferences. The number of height and weight measurements were standardized in 1938 to 4 heights and 5 weights per year. From 1946-60, 4 heights and 9 weights were recorded. In addition to anthropometric data, infectious disease experience prior to and during years of attendance were recorded, e.g., chickenpox was experienced by approximately 83% of boys, measles 83%, mumps 57%, whooping cough 31%, German measles 21%, and scarlet fever 7%.

Boys attended the school for 1 to 7 years. During the years under study, this school attracted a student population of primarily white, wealthy boys, the majority of whom were able to afford the best health care available at the time, as evidenced by a tonsillectomy rate of 75% and an appendectomy rate of 13%.

Preliminary analyses using a subset of the available data (n=650, last names beginning A-M) give the surprising finding that 14-year-old boys with some infectious diseases (i.e., mumps and German measles) are significantly taller than boys who did not experience those diseases, and mean height increases with number of infectious diseases. For example, among boys who were 14.0 to 14.49 years of age on September 1st, boys with a history of 1 infection are on average 60.8" (n=34), 2 infections 61.7" (n=129), 3 infections 62.4" (n=191), 4 infections 63.1" (n=100), 5 infections 64.1" (n=23), and 6 infections 63.9" (n=5).

This paper will use the entire data set to further explore these findings and to examine height in relation to number and type of infectious disease in all 0.5 year age categories and in relation to level of maturation (G1-G5), birth order, and other variables of interest.

Gait patterns and interlimb coordination in woolly opossums: how did ancestral primates move? P. LEMELIN, D. SCHMITT and M. CARTMILL, Department of Biological Anthropology and Anatomy, Duke University Medical Center, Durham, NC 27710.

With the exception of primates, diagonal sequence (DS) gaits are rare among mammals (Hildebrand, 1967). In addition, primates are unusual in their ability to use both lateral sequence (LS) and DS gaits

(Vilensky and Larson, 1989). Such ability is believed to have evolved in conjunction with a more mobile and manipulative forelimb for grasping and reaching in a terminal branch environment. To test this hypothesis, we examined gait kinematics in *Caluromys philander*, a marsupial with grasping extremities and ecology similar to those of cheirogaleids.

Captive subjects of *C. philander* were videotaped (60 fields/sec.) while walking on branches with different orientations. Subjects of *Microcebus murinus*, *Cheirogaleus medius*, and *Mirza coquereli* were also filmed on horizontal supports to compare the proportion of LS and DS gaits for a group of primates of similar ecomorphology to that of *Caluromys*. For each step, the sequence of footfalls and contact time of each limb were quantified using Peak Performance software (Motus 4.0).

Our data show that *Caluromys*, like many primates, is capable of using both DS and LS gaits depending on the nature of the substrate utilized. In contrast, cheirogaleids very rarely displayed LS gaits. On downward inclines and horizontal supports, woolly opossums relied primarily on LS gaits. On upward inclines and vertical supports, only DS gaits were used by *Caluromys*.

These results for *Caluromys* mirror those obtained by Vilensky et al. (1992) for squirrel monkeys. Under laboratory conditions, they found that squirrel monkeys prefer LS gaits when walking quadrupedally on treadmills, except for the steepest upward inclinations (+28°). Like *Caluromys*, squirrel monkeys relied exclusively on DS gaits when ascending such supports. This evidence suggests that increase of climbing in the locomotor repertoire of ancestral primates was an important factor in the evolution of DS gaits.

Funded by NSF grant SBR-9318750.

An ecomorphological model of the initial hominid dispersal from Africa W.R. LEONARD, S.C. ANTÓN, and M.L. ROBERTSON, Northwestern University, Evanston, IL 60208 and University of Florida, Gainesville, 32611

Hominid dispersal patterns contrast before and after 2 million years ago (Ma). Before 2 Ma hominids undergo limited dispersals similar in range, if not environment, to those of the living great apes, whereas afterward hominids disperse widely across the Old World. Previous models explain this dichotomy via technological innovations of the Acheulian tradition opening new niches. Yet recent geochronological evidence suggests that the first extra-African hominids antedate this technology. We look to living and fossil mammals to identify non-technological predictors of widely dispersing mammals.

Body size, diet quality, and other ecological variables influence home range (HR) size and thus the dispersion potential of mammals. In comparison with other paleodispersals, the diffusion coefficient (D) for *H. erectus* (*sensu lato*) is significantly larger (faster) than for other fossil primates, but is similar to mammals with significantly larger HRs and higher quality diets, such as fossil carnivores. D is based on variables of time, area, and intrinsic rate of increase (r) of a population, which we estimate from dates of 1.81 and 1.66 Ma for extra-African *H. erectus* and r's of 1.0 and 1.5% per annum. Without reference to fossil hominid morphology, these comparisons suggest that a shift in both foraging strategy and HR size was necessary for this first dispersal of hominids.

In order to explain whether such increases in HR size might be accounted for by ecological factors, we explored correlates of

variation in HR size in extant primates and human foragers. Within this sample variation in body size and diet quality explained 80% of the variation in HR size, with larger body sizes and higher quality diets requiring disproportionately greater HR sizes. This relationship was used to predict changes in hominid HR size. Postcranial remains suggest increasing body size in *H. erectus*. These changes in body weight coupled with modest increases in diet quality would have produced an 8 to 10 fold increase in HR size in *H. erectus*.

Thus ecological factors alone may explain the rapid rates of dispersal in *H. erectus* compared with earlier hominids, if diet quality improves in *H. erectus*. A potential source of dietary enrichment is the bovid biomass on the African savanna, which is itself migrating widely. That is, the initial hominid dispersal may be modelled as that of an opportunistic carnivore. We suggest that an increasingly intimate connection between hominids and bovids provides a dispersing impetus and obviates many of the issues faced by a dispersing mammal, such as finding food and water. Such a model situates *H. erectus* within an ecological context, although it is not an a-technological model since shifts in behavior (tool use/fire?) were likely necessary for accessing bovids and perhaps for predation control.

#### Integrating the inside with the outside:

Assessments of external and internal nasal parameters in extant humans. D. LEWIS, S. MARQUEZ, T. BROMAGE, K. MOWBRAY, D. BROADFIELD, and J.T. LAITMAN, Depts. of Cell Biology/Anatomy and Anthropology, Mount Sinai School of Medicine, NY, NY 10029, Hunter College, CUNY, NY, NY, Rutgers University, New Brunswick, NJ

Studies correlating ecogeographical conditions to the skeletal nasal region have largely relied on external parameters (e.g., nasal index) to assess relationships between climate and nasal dimensions. Use of this index alone, however, may provide only a partial understanding of relationships. This study investigates the integration of internal components of the human nasal complex with linear measures in order to explore the relationship between craniodental dimensions and constituents of the respiratory apparatus in a diverse sample of extant *Homo sapiens*.

A pooled mixed sex sample of adult crania (n=33) from N. America, Africa, Middle East, and Europe were selected from the American Museum of Natural History and measured with digital calipers to obtain ten craniodental measurements, as well as molar volume (MV). In addition, nasal cavity (NC), maxillary sinus (MS) and endocranial volumes were obtained via seed filling techniques. Piriform aperture areas (PAA) were obtained from CCD captured images. Images of the piriform aperture, captured using a CCD camera, were analyzed in Sigma Scan Pro to yield piriform aperture areas (PAA). Results using bivariate regressions show significant relationships between PAA and nasal breadth (NBD,  $r^2 = 0.42$ ,  $p < .05$ ), and also NC volume and nasal height (NHT,  $r^2 = 0.78$ ,  $p < .05$ ). No statistically significant relationships were observed between MV and MS, or skull length and NC volume.

Significant relationships between PAA and NBD suggest a close association between the respiratory vertical portions of the maxilla and internal nasal dimensions. The lack of significance between MV and MS size was somewhat surprising given the apparent intimate relationship between fully erupted molars and adult MS size. Data from this study suggest that the integration of internal and external dimensions of the nasal complex may give considerable greater insight into respiratory adaptations than use of external parameters alone. This research is supported by NSF-SBR9634519 and NIH 1-F31DC00255-01.